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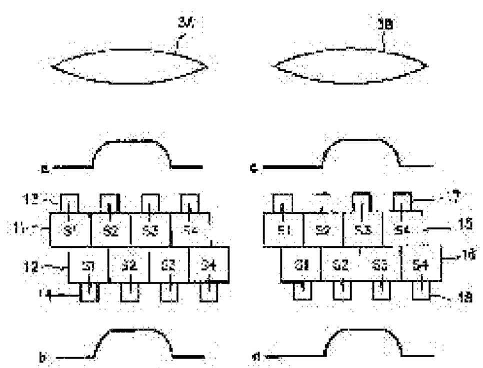
(54) **RANGE FINDING DEVICE AND COMPUTER READABLE STORAGE MEDIUM**



(57)Abstract:

PROBLEM TO BE SOLVED: To provide an image signal having a waveform having no uneaveness from an accumulation part on each side in the structure having charge accumulating parts on both sides of each sensor in a sensor array.

SOLUTION: First and second sensor arrays 11, 12 are provided so that each sensor S1-S4 is shifted, accumulation parts 13, 14 are provided to all sensors on one side of each sensor array. Third and fourth sensor arrays 15, 16 are also shifted

in the same manner with a shift, and accumulation parts 17, 18 are provided thereon, respectively. According to this, image signals (a), (b), (c), (d) obtained from each sensor array 11, 12, 15, 16 through each accumulation part 13, 14, 17, 18 have smooth waveforms.

(54) [Title of the Invention] DISTANCE MEASURING APPARATUS AND COMPUTER-READABLE STORAGE MEDIUM

(57) [Abstract]

[Problem] To obtain image signals whose waveforms are not jagged from storage units for electric charges are provided on the both sides of respective sensors in sensor arrays.

[Means for Solving the Problem] First and second sensor arrays 11 and 12 are structured such that respective sensors S1 to S4 are shifted from one another, and storage units 13 and 14 are provided with respect to all the sensors on one side of the respective sensor arrays, and third and fourth sensor arrays 15 and 16 as well are shifted from one another in the same way, and storage units 17 and 18 are provided respectively thereto.

[Effect] Image signals a, b, c, and d obtained from the respective sensor arrays 11, 12, 15, and 16 via the respective storage units 13, 14, 17, and 18 have smooth waveforms.

[Scope of Claims]

[Claim 1] A distance measuring apparatus comprising:

a first sensor array which consists of a plurality of photoelectric conversion elements being arrayed;

a second sensor array which consists of a plurality of photoelectric conversion elements being arrayed, and which is disposed parallel to the first sensor array in the array direction;

a third sensor array which consists of a plurality of photoelectric conversion elements being arrayed, and which is disposed at a predetermined distance from the first sensor array in the array direction; and

a fourth sensor array which consists of a plurality of photoelectric conversion elements being arrayed, and which is disposed parallel to the third sensor array in the array direction.

[Claim 2] The distance measuring apparatus according to claim 1, further comprising storing means for storing electric charges respectively so as to correspond to the respective photoelectric conversion elements in the first to fourth sensor arrays.

[Claim 3] The distance measuring apparatus according to claim 1, wherein the respective plurality of photoelectric conversion elements in the first and second sensor arrays are arrayed so as to be shifted from one another in the array direction, and the respective plurality of photoelectric conversion elements in the third and fourth sensor arrays are arrayed so as to be shifted from one another in the array direction.

[Claim 4] The distance measuring apparatus according to claim 1, further comprising:

shifting means for performing bit shift more than once on first and second image signals obtained by the first and second sensor arrays receiving light from an object image distance of which is to be measured;

first arithmetic means for determining first correlated values of the first and second image signals for every bit shift;

second arithmetic means for determining second correlated values of third and fourth image signals obtained by the third and fourth sensor arrays receiving light from the object image distance of which is to be measured;

third arithmetic means for determining third correlated values by adding the first correlated values and the second correlated values; and

fourth arithmetic means for determining a distance to the object distance of which is to be measured on the basis of a quantity of bit shift when a value most correlated among the third correlated values is obtained.

[Claim 5] A computer-readable storage medium storing thereon a program for executing:

a procedure for performing bit sift more than once on first and second image signals obtained by the first and second sensor arrays receiving light from an object image distance of which is to be measured;

a procedure for determining first correlated values of the first and second image signals for every bit shift;

means for determining second correlated values of third

and fourth image signals obtained by the third and fourth sensor arrays receiving light from the object image distance of which is to be measured;

third arithmetic means for determining third correlated values by adding the first correlated values and the second correlated values; and

a procedure for determining a distance to the object distance of which is to be measured on the basis of a quantity of bit shift when a value most correlated among the third correlated values is obtained.

[Detailed Description of the Invention]

[0001]

[Field of the Invention] The present invention relates to a distance measuring apparatus which is used for an AF device in a camera or the like, and which measures a distance to a measuring object, and a computer-readable storage medium used for the distance measuring apparatus, and in particular, to a distance measuring apparatus using a ring-shaped electric charge transfer unit.

[0002]

[Related Art] Conventionally, a distance measuring apparatus which makes the rounds of stored electric charges in which a light from an object (a measuring object) is photoelectrically converted, to be integrated, and which measures a distance to the object on the basis of the integrated voltage value using a ring-shaped CCD, has been proposed in, for example, Japanese Patent Application Laid-Open No. 5-22843. Further, a distance measuring apparatus in which the above apparatus has been improved, as simplistically shown in FIG. 4, has been proposed

in Japanese Patent Application Laid-Open No. 8-233571.

[0003] In FIG. 4, a floodlight unit 1 blinks on and off by being turned on and off at a predetermined interval. A light t from the floodlight unit 1 is irradiated on an unillustrated object via a floodlight lens 2. A reflected light in which a reflected light of light floodlit during a period when the floodlight unit 1 is on (during the lighting), and a reflected light from outside light are added, and a reflected light only from outside light during a period when the floodlight unit 1 is off (during the lighting-off) are alternately obtained from the object. These reflected lights r are formed as images on a sensor array 5 consisting of sensors S1 to S4 formed from photoelectric conversion elements of a sensor device 4 via a light-receiving lens 3.

[0004] Electric charges converted in the sensors S1 to S4 during the lighting of the floodlight unit 1 are sampled in sampling units ST01 to ST04 via an electronic shutter ICG, and thereafter, those are transferred to respective storage units ST1 provided so as to correspond to respective integration units S1 to S4. Further, electric charges converted in the sensors S1 to S4 during the lighting-off of the floodlight unit 1 are, in the same way, transferred to respective storage units ST2 via the electronic shutter ICG and the integration units ST01 to ST04.

[0005] Note that an initialization unit CCLR carries out initialization before the above-described integration is carried out, and during initialization, the sampling units ST01 to ST04 do not operate, and electric charges do not move to the storage units ST1 and ST2. Further, the electronic

shutter ICG controls a quantity of electric charge of the signal when a signal is too large. In addition thereto, the electronic shutter ICG has a function of abandoning electric charges generated in respective transfer stages C1 to C8 of a ring transfer unit 7 which will be described later during the initializing.

[0006] At a point in time when the electric charges during the lighting and during the lighting-off are concentrated together in the respective storage units ST1 and ST2, those are transferred to transfer stages A1 to A8 of a charge transfer unit 6 via a shift gate SH, and are further transferred to the transfer stages of C1 to C8 via transfer stages B1 to B4 in synchronization with the period at which the floodlight unit 1 is turned on and off. Here, because the above-described floodlighting and transfer operation are carried out in synchronization with one another, electric charges obtained every time the floodlighting is turned on and off are respectively added at the C1 to C8 with respect to each of the sensors S1 to S4, to be integrated.

[0007] An electric charge excluding unit 8 consisting of SK1 to SK3 has a function of preventing the C1 to C8 of the ring transfer unit 7 from being saturated by excluding a given quantity of electric charges made redundant when a quantity of a pair of electric charges during the lighting and lighting-off by a skim unit SCLR. At that time, because charges are stored in each pair of ST1 and ST2 so as to correspond to each of the respective sensors S1 to S4, it is possible to obtain only the signal component from floodlighting by determining a difference between the ST1 and ST2.

[0008] In accordance with the above-described structure, by repeating the blinking of the floodlight unit 1, in an output signal S obtained from the ring transfer unit 7 via an amplifier FG, only the signal component from which the effects of outside light and noise have been eliminated is left. Accordingly, provided that two sensor devices 4 having the same structure are used, and those are disposed at a predetermined interval, it is possible to precisely determine a distance to an object by performing correlation operations by use of the principle of triangulation on the basis of the respective output signals S. There is disclosed a distance measuring apparatus having such a structure in, for example, Japanese Patent Application Laid-Open No. 9-105623.

[0009] Further, the storage units ST1 and ST2 are provided on one side of the sensor array 5 in FIG. 4 (the upper side in the drawing). However, in a case of using the two sensor devices 4, as shown in FIG. 5, a structure in which the storage units are provided on the both sides of the sensor array 5 (on the upper side and the lower side) as well has been proposed. FIG. 5 shows the sensor array portions of the two sensor devices, and two sensor arrays 5A and 5B are provided to two light-receiving lenses 3A and 3B. Storage units 21A and 22A are provided alternately to the upper side and the lower side of the sensors S1 to S8 structuring the sensor array 5A, and storage units 21B and 22B are provided alternately to the upper side and the lower side of the sensors S1 to S8 structuring the sensor array 5B. Note that, in the drawing, the electronic shutter, the sampling units, and the like are omitted.

[0010] In the above-described structure, an image serving as an object image electrically subjected to light, which is obtained from the storage unit 21A of the sensor array 5A, is denoted by e, and an image obtained from the storage unit 22A is denoted by f. Further, an image obtained from the storage unit 21B of the sensor array 5B is denoted by h, and an image obtained from the storage unit 22B is denoted by i. Then, an image of g in which the images of e and f are synthesized is obtained as an output at the sensor array 5A side, and an image of j in which the images of h and i are synthesized is obtained as an output at the sensor array 5B side.

[0011] Provided that a correlation operation is performed by use of these images of g and j, it is possible to determine a distance to the object. Further, provided that the apparatus is structured in this way, a pitch of the array among the sensors S1 to S8 in the sensor arrays 5A and 5B can be made fine, which makes it possible to improve the precision thereof.

[0012]

[Problems to Be Solved by the Invention] However, there are cases in which the respective images denoted by g and j in FIG. 5 have, not smooth waveforms as shown by the dotted lines, but jagged waveforms as shown by the solid lines due to a variation in a charge transfer efficiency or amplified gain, or the like. When a correlation operation is performed by use of such waveforms, it is impossible to obtain a correct distance-measured value under the influence of the above-described jagged portions, and in some cases, it may become impossible to measure distance. Further, in a case of the structure in which the storage units are arrayed alternately

on the upper side and the lower side of the sensors S1 to S8, only on the upper side or on the lower side, images are thinned out such as e, f, h, and i to be discontinuous, which makes it necessary to carry out processing for sorting the images to be synthesized, and therefore, the above-described jaggy are easily generated.

[0013] For example, there is disclosed the concept that it is impossible to precisely integrate those when minute signals are integrated in synchronization with timings in which floodlighting is turned on and off. However, in such a case particularly, at the time of preparing sensor arrays, when masks of IC on the upper side and the lower side are shifted up and down, the effects thereof are brought about in a direction opposite to one another on the upper side and the lower side, which makes the above-described jaggy greater in some cases.

[0014] An abject of the present invention is to solve the above-described problems, and to prevent the emergence of the above-described jaggy.

[0015]

[Means of Solving the Problems] In the distance measuring apparatus according to the present invention, there are provided a first sensor array which consists of a plurality of photoelectric conversion elements being arrayed, a second sensor array which consists of a plurality of photoelectric conversion elements being arrayed, and which is disposed parallel to the first sensor array in the array direction, a third sensor array which consists of a plurality of photoelectric conversion elements being arrayed, and which is

disposed at a predetermined distance from the first sensor array in the array direction, and a fourth sensor array which consists of a plurality of photoelectric conversion elements being arrayed, and which is disposed parallel to the third sensor array in the array direction.

[0016] In the recording medium according to the present invention, a program for executing a procedure for performing bit shift more than once on first and second image signals obtained by the first and second sensor arrays receiving light from an object image distance of which is to be measured, a procedure for determining first correlated values of the first and second image signals for every bit shift, a means for determining second correlated values of third and fourth image signals obtained by the third and fourth sensor arrays receiving light from the object image distance of which is to be measured, a third arithmetic means for determining third correlated values by adding the first correlated values and the second correlated values, and a procedure for determining a distance to the object distance of which is to be measured on the basis of a quantity of bit shift when a value most correlated among the third correlated values is obtained.

[0017]

[Embodiment of the Invention] Hereinafter, an embodiment of the present invention will be described with reference to the drawings. In FIG. 1, with respect to the first light-receiving lens 3A, a first sensor array 11 and a second sensor array 12, which respectively consist of sensors S1 to S4, are provided to be adjacent parallel to one another, and so as to array the respective sensors S1 to S4 zigzag by being shifted from one

another by 1/2 of a pitch thereamong. First storage units 14 and second storage units 15 are provided to the respective sensors S1 to S4 of the respective sensor arrays 11 and 12.

[0018] In the same way, with respect to the second light-receiving lens 3B, a third sensor array 15 and a fourth sensor array 16, which respectively consist of the sensors S1 to S4, are provided to be adjacent parallel to one another, and so as to array the respective sensors S1 to S4 zigzag by being shifted from one another by 1/2 of a pitch thereamong. Third storage units 17 and fourth storage units 18 are provided to the respective sensors S1 to S4 of the respective sensor arrays 11 and 12. Note that these sensor arrays 11, 12, 15, and 16 are arranged so as to direct the acceptance surfaces toward the light-receiving lenses 3A and 3B.

[0019] Next, operations will be described. Electric charges from the first sensor array 11 are stored in the first storage unit 13, and electric charges from the second sensor array 12 are stored in the second storage unit 14. An image obtained from the first storage unit 13 is denoted by a, and an image obtained from the second storage unit 14 is denoted by b. Because these images of a and b are formed from all electric charges of the sensors S1 to S4, those are continuous, and even when there is a variation in transfer efficiency or amplified gain between the upper side and the lower side, there is no case in which jaggy is generated.

[0020] In the same way as in the third and fourth sensor arrays 15 and 16 as well, images denoted by c and d which are continuous without jaggy are respectively obtained from the third and fourth storage units 17 and 18.

[0021] FIG. 2 shows a structure of an image processing apparatus for determining a distance on the basis of the image signals of the respective images a, b, c, and d, and after the respective image signals are converted into digital image data by an A/D converter 20, those are transmitted to a microcomputer 21 to be processed, and a distance L is determined. The microcomputer 21 executes processing along a program according to a flowchart shown in FIG. 3, which is stored in a storage medium 22 such as a ROM according to the present invention. Note that a semiconductor memory, an optical disk, an optical magnetic disk, a magnetic medium, or the like may be used as the storage medium 22.

[0022] Next, operations will be described by use of FIGS. 2 and 3. At step S1, storage of electric charges into the respective storage units 13, 14, 17, and 18 is started. At step S2, it is checked whether or not a predetermined quantity of electric charges is stored, and when the predetermined quantity of electric charges is stored, the storage is completed at step S3. Next, at step S4, the respective image signals of a, b, c, and d obtained from the respective storage units are converted into image data by the A/D converter 20, and those are input into the microcomputer 21. Then, at step S5, a default value of a quantity of bit shift x is set to 0. Thereafter, the image data of a and b are shifted by x bits (an amount of x of the sensors S1 to S4) at step S6.

[0023] Next, at step S7, first correlated value are obtained by performing correlation operations on the basis of the bit-shifted image data of a and b. Further, at step S8, second correlated values are determined on the basis of the image

data of b and c. Then, at step S9, sums of the first correlated values and the second correlated values are determined, which are defined as third correlated values f(n).

[0024] Next, at step S10, 1 is added to x. Thereafter, it is checked whether or not x > n is realized at step S11, and the processings at steps S6 to S10 are repeatedly performed until x > n is realized. Here, n is a quantity of bit shift determined by a distance range to be measured. When x > n is realized, a value of x most correlated among the third correlated values f(n) is determined at step S12. Then, at step S13, a distance L is determined on the basis of the determined value of x by performing an operation.

[0025] The reason why the first correlated values and the second correlated values are added at step S9 is because, since those are most correlated at a same distance, i.e., a same quantity of bit shift, it is possible to take a greater change to be easily searched by adding those more than the case in which a portion at which data are most correlated is searched independently of one another. In this way, it can be expected that an S/N ratio double that in a case of being most correlated independently.

[0026]

[Effect of the Invention] As described above, in accordance with the present invention, the first and second sensor arrays are provided parallel to one another, and the third and fourth sensor arrays are provided to be spaced from those, which makes it possible to obtain image signals with continuous waveforms from the respective sides of the respective sensor arrays, and therefore, it is possible to carry out highly

precise distance measurement without generating jaggy described above.

[0027] Further, by providing means for storing electric charges respectively to the respective photoelectric conversion elements in the first to fourth sensor arrays, it is possible to carry out highly precise distance measurement without the affect of noise or the like. Moreover, because the respective photoelectric conversion elements of the respective first and second sensor arrays and third and fourth sensor arrays are shifted to be zigzag arrays, it is possible to obtain image signals of waveforms without jaggy while having a structure substantially the same as that of the conventional distance measuring apparatus of FIG. 4.

[0028] Further, first correlated values are determined while performing bit shift on the first and second image signals obtained from the first and second sensor arrays, and second correlated values are determined from the third and fourth image signals obtained from the third and fourth sensor arrays, and a distance to a measuring object is determined on the basis of a quantity of bit shift in a case most correlated among the third correlated values obtained by adding the first and second correlated values, which improves an S/N ratio, and it is possible to carry out highly precise distance measurement.

[Brief Description of Drawings]

[FIG. 1] FIG. 1 is a block diagram showing an embodiment of the present invention.

[FIG. 2] FIG. 2 is a block diagram showing an image processing apparatus for image signals.

[FIG. 3] FIG. 3 is a flowchart showing operations.

[FIG. 4] FIG. 4 is a block diagram of a conventional distance measuring apparatus.

[FIG. 5] FIG. 5 is a block diagram showing a principal part of another conventional distance measuring apparatus.

[Explanation of Reference Symbols]

3A First light-receiving lens

3B Second light-receiving lens

11 First sensor array

12 Second sensor array

15 Third sensor array

16 Fourth sensor array

13 First storage unit

14 Second storage unit

17 Third storage unit

18 Fourth storage unit

21 Microcomputer

22 Storage medium

FIG. 2

21 Microcomputer

22 Storage medium

FIG. 3

Start

S1 Start storage

S2 Predetermined quantity?

S3 Complete storage

S4 Convert image signals from analog to digital

S6 Shift image data of a and b by x bits

S7 First correlated values of image data of a and b

S8 Second correlated values of image data of c and d

S9 Sums of first and second correlated values → third correlated values f(n)

S12 Determine x which is most correlated among f(n)

S13 Determine distance L on the basis of x

End